Physical Nature of Mesons and Principle of Decay in the Non-Standard Model

Daniele Sasso *

Abstract

In the Standard Model (SM) mesons are considered hadrons like baryons and they have therefore a quark structure. Moreover they are considered bosons because of the exclusive property in the world of massive elementary particles to have integer and equal to zero spin. In this paper we propose both a critical reading of these properties and a new classification for mesons based on the Non-Standard Model (NSM) in which they have a leptonic and electrodynamic nature. The introduction then of the Principle of Decay in the new NSM involves a different classification of elementary particles and at the same time different fundamental physical properties like the spin. In this treatise the complex structure of mesons isn't considered because their hadron nature comes down and because of their instability we introduce the energy new particle called meson neutrino. Moreover we identify a different physical behaviour between charged mesons and neutral mesons and let us propose for neutral mesons a physical structure compatible with the positronium.

1. Introduction

In the SM mesons are considered hadrons like baryons but unlike these they are composed only of a couple of quarks instead of a tern. So mesons would have in the SM no bond with electrodynamic particles of the electron family.
We wonder now if this theoretical approach concerning mesons is correct or if on the contrary there is a real bond of mesons with electrodynamic mass.
A possible answer to this question may derive from the painstaking study of decay processes of mesons that, as it is known, are unstable particles. We observe that mesons are the only particles which don't have in their family a stable parent as electron for the lepton family and as proton for the baryon family.
This consideration can generate an appropriate critical remark on the physical nature of mesons because in default of a stable parent particle we are induced to think mesons aren't an independent family of particles but rather they are a subfamily included into a wider family. Moreover in the SM mesons have an integer and equal to zero angular spin for which they have boson nature, we will demonstrate in the Non-Standard Model (NSM) mesons have different values of spin according to their electric charge.

* e_mail: dgsasso@alice.it

2. Meson subfamily

In SM mesons belong to an intermediate family of particles placed between leptons (light particles) and baryons (heavy particles). Anyway mesons are considered more similar to baryons than to leptons, in fact they are classified together with baryons into the hadron family because of the quark common structure.

A very important and in a few respects strange characteristic too regards meson spin which in SM is integer and equal to zero while in the same model baryons have semi-integer and equal to (1/2)ħ spin as leptons.

The first meson (pion π) was theorized in 1935 by Yukawa who supposed pion was the intermediate particle generating the strong nuclear force among protons and neutrons inside nucleus.

Later three different pions were discovered: the positive pion π^+ and the negative pion π^- with the same value of mass $273{,}1m_e=139{,}55MeV/c^2$ (m_e is mass of resting electron) and the neutral pion π^o with a bit lower mass $264{,}1m_e=134{,}96MeV/c^2$.

Each pion has its own antiparticle which coincides with the pion with equal electric charge for totaling three diverse particles.

Pion π was found in the cosmic radiation in 1947 and the year after it was found into tracks of Berkeley accelerator. Later in years 1950-60 meson k was discovered in two versions: the positive meson k^+ with mass $966{,}4m_e=493{,}83MeV/c^2$ and the neutral meson k^o with mass $974{,}1m_e=497{,}77MeV/c^2$. The two antiparticles of these two mesons ($\underline{k}^+$ and $\underline{k}^o$), unlike pions, in SM are considered different from the parallel particles for totaling four diverse particles.

In 1961 the neutral meson η^o with mass $1074m_e=548{,}81MeV/c^2$ was discovered and afterwards the meson list expanded much with the discovery of new particles which often had very strange properties: mesons B , mesons D and then still vector mesons (meson ρ, meson ω^o, meson φ^o, meson J/Ψ, meson Y, etc.).

The strange physical behaviour of these particles induces to think that a their different identification can be useful for a better classification of stable and unstable elementary particles.

In SM then strangeness has assumed the meaning of a real physical property but in NSM the strangeness has nothing of the physical property and very likely its introduction in SM had only the aim of justifying and masking the misunderstanding of elementary fundamental structures of matter and energy.

3. Physical properties of mesons

In SM mesons and baryons are considered hadrons and therefore belonging to the same group of non-entirely elementary particles because of quark their structure.

Mesons have various values of mass and a few of them take very large masses as mesons B which have greater masses than $10000m_e$ and as meson Y which has greater mass than $18000m_e$.

Meson electric charge then can be positive or negative but can be also neutral (like pion π^o, meson k^o, meson η^o, meson B^o, meson D^o, vector meson ρ^o, vector meson ω^o, vector meson φ^o, etc.).
I think that elementary particles with zero electric charge, as neutral mesons, have very interesting properties and therefore they have to be further explored.
The most strange physical characteristic of mesons in SM is the spin which is zero for all mesons. This property is altogether in conflict with both the Theory of Reference Frames and the Non-Standard Model where a physical relation[1][2] between spin and electric charge has been defined and demonstrated :

$$q_s = \frac{k}{n}\,\frac{\hbar}{2e}\,Q \qquad (1)$$

in which $Q=\pm ne$, k and n are integer numbers and "e" is the electric charge in absolute value of electron.
From (1) we deduce that particles have zero spin only if they have zero electric charge. Because the greater part of mesons have positive or negative electric charge and because for unbound free particles is k=1, we deduce in NSM, unlike SM, mesons with positive electric charge have spin $+(1/2)\hbar$ and mesons with negative electric charge have spin $-(1/2)\hbar$. Only mesons with zero electric charge have in our model zero spin.
Another very important physical property for all unstable particles, and therefore also for mesons, is their way of decay. Let' s cite here in table 1 a few typical processes of decay for some mesons

$\pi^+ \longrightarrow \mu^+ + \nu_\mu$	$\pi^+ \longrightarrow e^+ + \nu_e$	
$\pi^- \longrightarrow \mu^- + \nu_\mu$	$\pi^- \longrightarrow e^- + \nu_e$	
$\pi^o \longrightarrow \gamma + \gamma$	$\pi^o \longrightarrow \gamma + e^- + e^+$	
$k^+ \longrightarrow \pi^+ + \pi^o$	$k^+ \longrightarrow \mu^+ + \nu_\mu$	$k^+ \longrightarrow \pi^o + e^+ + \nu_e$
$k^- \longrightarrow \pi^- + \pi^o$	$k^- \longrightarrow \mu^- + \nu_\mu$	$k^- \longrightarrow \pi^o + e^- + \nu_e$
$k^o \longrightarrow \pi^+ + \pi^-$	$k^o \longrightarrow \pi^o + \pi^o$	$k^o \longrightarrow \pi^\pm + e^\mp + \nu_e$
$k^o \longrightarrow \pi^\pm + \mu^\mp + \nu_\mu$	$k^o \longrightarrow \pi^+ + \pi^- + \pi^o$	$k^o \longrightarrow \pi^o + \pi^o + \pi^o$
$\eta^o \longrightarrow \gamma + \gamma$	$\eta^o \longrightarrow \pi^+ + \pi^- + \pi^o$	$\eta^o \longrightarrow \pi^o + \pi^o + \pi^o$

Table1. Typical processes of decay for a few mesons.

For other mesons (like mesons B, D and vector mesons) processes of decay are quite controversial and very varied.
From the table we deduce some important considerations:

a. Mesons with negative unitary electric charge (Q=−e) decay directly or through intermediate decays to electrons and energy quanta.
b. Mesons with positive unitary electric charge (Q=+e) decay directly or through intermediate decays to positrons and energy quanta.
c. Neutral mesons with zero electric charge (Q=0) have different ways of decay, at times they decay directly and completely to energy quanta, sometime decay to energy quanta and to electron-positron pairs. Anyway the generation of electron-positron pairs is completely explained by the phenomenon of materialization[1] of energy quanta.

4. The Principle of Decay

As per preceding considerations we are able to define and to enunciate the following Principle of Decay that is valid in NSM for all processes of decay, also for those here not considered:

"Each unstable elementary particle belongs to the primary family of the stable particle to which the unstable particle decays through one direct decay or more intermediates decays".

The application of this principle allows to understand better some physical behaviours in the microphysical world and also to simplify enough the complex system of elementary particles.
Specifically we will apply this principle to the family of electrodynamic particles that have electron as parent relative to particles with negative electric charge and have positron as parent relative to particles with positive electric charge.
This principle isn' t defined in arbitrary way but derives directly from preceding considerations and also from results demonstrated in papers that are reported in references[1][2][3] . As per the Principle of Decay it is manifest all known negative leptonic particles (negative muon, negative tauon) belong to electron family.
Similarly we can claim both the muon antiparticle (positive muon) and the tauon antiparticle (positive tauon) belong to positron family.
The most interesting result of the Principle of Decay nevertheless is that also charged mesons belong to electron or positron primary families according to their electric charge. Consequently also charged mesons have an electrodynamic nature and being unstable particles have negative electrodynamic mass.
Neutral mesons instead have a different physical behaviour because, like it is possible to see in tab.1, they decay directly or through intermediate decays to energy quanta or to electron-positron pairs. From this consideration we can deduce neutral mesons aren' t electrodynamic elementary particles but rather complex particles.

5. Charged mesons and meson neutrinos in the Non-Standard Model

Considering the table1 we are induced to think necessarily something into that table must be revised. In fact in concordance with processes of direct decay to the parent of family relative to charged pions, processes of direct decay must be changed like this

$$\pi^+ \longrightarrow e^+ + \nu_\pi^+ \qquad (2)$$
$$\pi^- \longrightarrow e^- + \nu_\pi^-$$

where ν_π^+ and ν_π^- are pion neutrinos and not electron neutrinos: in fact electron neutrinos are produced in the process of neutron decay. Because pions π^+ and π^- have the same mass and also electron and positron have the same mass we are also induced to think neutrinos ν_π^+ and ν_π^- have the same physical properties.
In particular we can calculate the frequency of two neutrinos knowing that masses (negative because of their instability) of two unstable pions are equal to $-273{,}1m_e$

$$f = \frac{\Delta m\, c^2}{h} = 3{,}38 \times 10^{22}\ \text{Hz} \qquad (3)$$

Pion neutrinos belong, as it was predictable, to the frequency band of the delta radiation, in fact all processes of decay of unstable electrodynamic particles generate energy quanta belonging to the delta radiation.
Also for mesons k a similar process of direct decay must be valid and in NSM we assume there are two charged mesons, as for pions,

$$k^+ \longrightarrow e^+ + \nu_k^+ \qquad (4)$$
$$k^- \longrightarrow e^- + \nu_k^-$$

where ν_k^+ and ν_k^- are neutrinos k. Because the two charged mesons k have the same electrodynamic mass the two neutrinos k have equal physical properties, in particular with regard to characteristics of frequency and wavelength.
For the two neutrinos ν_k^+ and ν_k^- , because mass of the two mesons k^+ and k^- is equal to $m=-966{,}4m_e$, we have

$$f = \frac{\Delta m\, c^2}{h} = 1{,}19 \times 10^{23}\ \text{Hz} \qquad (5)$$

Of course also neutrinos of the two charged mesons k are energy quanta belonging to the band of the delta radiation.
With regard to other charged mesons let' s consider now the meson B_c^+ which among pseudoscalar mesons is the meson with the most great mass: $-12281{,}8m_e$.
If B_c^+ is really a meson it must decay directly to the family parent, that in that case is the positron, in concordance with the following process

$$B_c^+ \longrightarrow e^+ + \nu_{Bc}^+ \qquad (6)$$

The neutrino ν_{Bc}^+ of the meson B_c^+ has the characteristic frequency

$$f = \frac{\Delta m\, c^2}{h} = 15{,}15\times10^{23}\ \mathrm{Hz} \qquad (7)$$

that belongs still to the delta radiation.
Among charged vector mesons let' s consider here mesons ρ^+ and ρ^- which have the same mass -1517,42m_e. Processes of direct decay of the two mesons are

$$\rho^+ \longrightarrow e^+ + \nu_\rho^+ \qquad (8)$$
$$\rho^- \longrightarrow e^- + \nu_\rho^-$$

Because the two mesons have the same mass, the two neutrinos ν_ρ^+ and ν_ρ^- have the same frequency within the delta radiation

$$f = \frac{\Delta m\, c^2}{h} = 1{,}87\times10^{23}\ \mathrm{Hz} \qquad (9)$$

Other charged vector mesons of family have the same behaviour and because they have different masses have also different frequencies and wavelengths always nevertheless within the band of the delta radiation.
According to preceding considerations we are able to update the diagram of unstable charged electrodynamic particles[3]

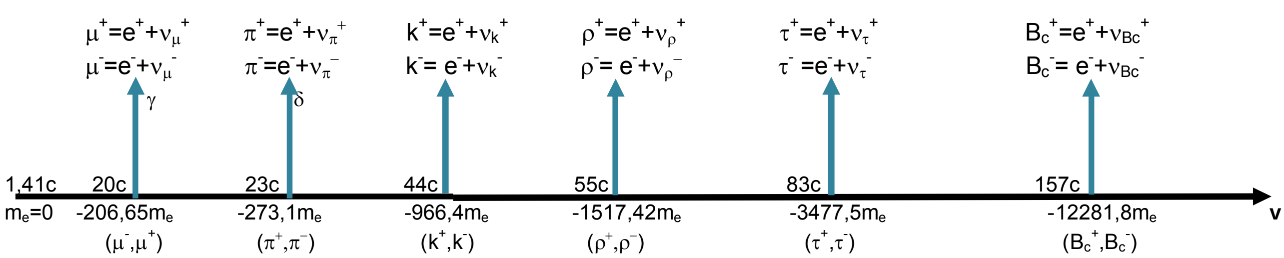

Fig.1 Updated graph relating to unstable electrodynamic particles with negative electrodynamic mass. Graph is out of scale. m_e is the mass of resting electron. Graph starts from the critical speed v_c=1,41c where electrodynamic mass is zero. Particle speeds are rounded down.

Knowing average lifes of electrodynamic particles and calculating their speed as per the relationship of variation of electrodynamic mass with the speed

$$m = m_e\left(1 - \frac{1}{2}\frac{v^2}{c^2}\right) \qquad (10)$$

we are able to calculate distances travelled by unstable particles during the process of decay (tab.2).

particle	average life τ_m [s]	speed v [m/s]	travelled distance d [m]
muon (μ)	$2{,}2 \times 10^{-6}$	20,38c	13451
pion (π)	$2{,}6 \times 10^{-8}$	23,41c	182,60
meson k	$1{,}23 \times 10^{-8}$	43,99c	162,32
meson ρ	$0{,}4 \times 10^{-23}$	55,11c	$66{,}13 \times 10^{-15}$
tauon (τ)	$290{,}6 \times 10^{-15}$	83,41c	$7{,}27 \times 10^{-3}$
meson B_c^+	$0{,}46 \times 10^{-12}$	156,73c	$21{,}6 \times 10^{-3}$

Tab.2 Distances travelled by unstable charged particles during decay.

Let us observe the travelled distance by the vector meson ρ isn' t tuned in to other travelled distances.
The travelled distance by muon instead explains very clearly because muons are the only unstable cosmic particles which after having been produced by the impact with the earth's atmosphere are able to reach the surface of the earth.
With regard to the spin, which is certainly one of the most important physical properties of particles, as we have already specified, in NSM positive mesons have spin equal to $+(1/2)\hbar$ and negative mesons have spin equal to $-(1/2)\hbar$.

6. Neutral mesons

All neutral mesons have typical ways of decay, in fact they decay always to energy quanta or to electron-positron pairs. As per this consideration we are induced to think neutral mesons aren' t elementary massive particles but rather particles with complex structure and therefore their instability is due to an excess of intrinsic energy with respect to the state fundamental.
Anyway we can define physical characteristics of neutral mesons and to that end let us consider, among scalar mesons, the pion π_o, the meson k_o, the particle η_o, the meson B_o, the meson D_o. Among neutral vector mesons we consider mesons: ρ^o, ω^o, φ^o, J/ψ^o e Y^o.
The main physical property of all neutral mesons is that their spin, in concordance with the NSM, is zero because of their zero electric charge.

6a. Neutral pion π_o has an equivalent conventional mass $264{,}1m_e$ and two typical ways of decay

$$\pi^o \longrightarrow \gamma + \gamma \tag{11}$$
$$\pi^o \longrightarrow \gamma + e^- + e^+ \tag{12}$$

The total energy of neutral pion π_o is 134,96 MeV/c^2 and therefore for (11) every energy quantum has a frequency

$$f = \frac{m_{\pi}{}^{o}\, c^2}{2h} = 1{,}63{\times}10^{22}\text{Hz} \tag{13}$$

It is manifest because of (13) the two energy quanta belong to the delta radiation rather than to the gamma radiation for which the (11), valid in SM, must be replaced, in concordance with the NSM, with the following relationship

$$\pi^o \longrightarrow \delta_\pi{}^o + \delta_\pi{}^o \tag{14}$$

Considering also the relation (12) it is altogether right to think the pion π_o can be a state at high energy of positronium. Positronium is in every state of energy an unstable structure, composed of one electron and one positron that are bound weakly. It decays through a process of annihilation to 2, 3, 4 or 5 energy gamma quanta. Like this the pion π_o, according to the (12), decays in a first period of the decay process to one positronium at low energy more one energy quantum which also in that case belongs to the delta radiation for which the (12) can be revised in the more correct shape

$$\pi^o \longrightarrow \delta_\pi{}^o + e^- + e^+ \tag{15}$$

Later positronium experiences a process of annihilation to 2 or 3 or 4 or 5 energy gamma quanta for which the pion π_o can decay to 6 energy quanta where one quantum belongs to the delta radiation and the others to the gamma radiation. The energy delta quantum $\delta_\pi{}^o$ can be considered the neutrino of the pion π^o and the process of decay described in the relation (14) can represent the conventional annihilation of the pion π^o to the neutrino-antineutrino pair.

6b. Neutral meson k^o has different ways of decay, as described in tab. 1:

$$\begin{aligned}
k^o &\longrightarrow \pi^+ + \pi^- \\
k^o &\longrightarrow \pi^o + \pi^o \\
k^o &\longrightarrow \pi^\pm + e^\mp + \nu_e \\
k^o &\longrightarrow \pi^\pm + \mu^\mp + \nu_\mu \\
k^o &\longrightarrow \pi^+ + \pi^- + \pi^o \\
k^o &\longrightarrow \pi^o + \pi^o + \pi^o
\end{aligned} \tag{16}$$

We observe the meson k^o has numerous ways of intermediate decay to pions and, among end products of decay, has electron-positron pairs (positronium) and energy delta quanta different from delta quanta of the neutral pion π^o because the k^o mass is $974{,}1m_e$ which is very different from the π^o mass.
Certainly the meson k^o must present also the direct decays, absent in the list (16),

$$k^o \longrightarrow \delta_k{}^o + \delta_k{}^o \qquad (17)$$
$$k^o \longrightarrow \delta_k{}^o + e^- + e^+ \qquad (18)$$

in which the neutrino $\delta_k{}^o$ (neutrino of meson k^o) has the following value of delta frequency

$$f = \frac{m_k{}^o\, c^2}{2h} = 6{,}0 \times 10^{22} Hz \qquad (19)$$

6.c The neutral meson η_o has the following ways of decay altogether similar to preceding neutral mesons

$$\eta^o \longrightarrow \delta_\eta{}^o + \delta_\eta{}^o$$
$$\eta^o \longrightarrow \pi^+ + \pi^- + \pi^o \qquad (20)$$
$$\eta^o \longrightarrow \pi^o + \pi^o + \pi^o$$

Because the neutral meson η_o has mass $1074m_e$ we infer that its neutrino $\delta_\eta{}^o$ has the delta frequency

$$f = \frac{m_\eta{}^o\, c^2}{2h} = 6{,}6 \times 10^{22} Hz \qquad (21)$$

6.d The neutral meson B^o has mass $10331{,}76m_e$ and among its numerous ways of decay we want here to consider the process of direct decay

$$B^o \longrightarrow \delta_B{}^o + \delta_B{}^o \qquad (22)$$

where the neutrino $\delta_B{}^o$ of the meson B^o has the delta frequency

$$f = \frac{m_B{}^o\, c^2}{2h} = 6{,}37 \times 10^{23} Hz \qquad (23)$$

6.e The neutral meson D^o has mass $3649{,}39m_e$ and the way of direct decay

$$D^o \longrightarrow \delta_D{}^o + \delta_D{}^o \qquad (24)$$

where the neutrino $\delta_D{}^o$ has the typical frequency of the delta band

$$f = \frac{m_D{}^o\, c^2}{2h} = 2{,}25 \times 10^{23} Hz \qquad (25)$$

6.f Neutral vector mesons ρ^o, ω^o, φ^o, J/ψ^o and Y^o have the following characteristic masses

$$
\begin{aligned}
m_{\rho}{}^{o} &= 1517{,}59m_e \\
m_{\omega}{}^{o} &= 1531{,}60m_e \\
m_{\varphi}{}^{o} &= 1995m_e \qquad (26)\\
m_{J/\psi}{}^{o} &= 6060{,}5m_e \\
m_{Y}{}^{o} &= 18513{,}31m_e
\end{aligned}
$$

and therefore, considering the process of direct decay, for each of preceding neutral vector mesons we have

$$
\begin{aligned}
\rho^o &\longrightarrow \delta_{\rho}{}^{o} + \delta_{\rho}{}^{o} \\
\omega^o &\longrightarrow \delta_{\omega}{}^{o} + \delta_{\omega}{}^{o} \\
\varphi^o &\longrightarrow \delta_{\varphi}{}^{o} + \delta_{\varphi}{}^{o} \qquad (27)\\
J/\Psi^o &\longrightarrow \delta_{J/\Psi}{}^{o} + \delta_{J/\Psi}{}^{o} \\
Y^o &\longrightarrow \delta_{Y}{}^{o} + \delta_{Y}{}^{o}
\end{aligned}
$$

We deduce the following characteristic frequencies of associated neutrinos

$$
\begin{aligned}
f_{\rho}{}^{o} &= 9{,}36 \times 10^{22}Hz \\
f_{\omega}{}^{o} &= 9{,}44 \times 10^{22}Hz \\
f_{\varphi}{}^{o} &= 12{,}3 \times 10^{22}Hz \qquad (28)\\
f_{J/\psi}{}^{o} &= 37{,}4 \times 10^{22}Hz \\
f_{Y}{}^{o} &= 114{,}2 \times 10^{22}Hz
\end{aligned}
$$

All frequencies calculated in (28) belong to the frequency band of the delta radiation.

As per our considerations we can claim in the end the family of electrodynamic particles embraces in the order of the Non-Standard Model three subfamilies:

a. Electron subfamily
b. Positron subfamily
c. Positronium subfamily.

References

[1] D. Sasso, On Primary Physical Transformations of Elementary Particles: the Origin of Electric charge, viXra.org, 2012, id:1202.0053

[2] D. Sasso; Beta Radiation, Gamma Radiation and Electron Neutrino in the Process of Neutron Decay; viXra.org, 2012, id: 1205.0052

[3] D. Sasso, On the Stability of Electrodynamic Particles: the Delta Radiation, viXra.org, 2012, id: 1210.0002